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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/711,015	08/18/2004	Jei-Ming Chen	NAUP0596USA	5014
27765	7590	05/03/2006	EXAMINER	
NORTH AMERICA INTELLECTUAL PROPERTY CORPORATION P.O. BOX 506 MERRIFIELD, VA 22116			QUINTO, KEVIN V	
			ART UNIT	PAPER NUMBER
			2826	

DATE MAILED: 05/03/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

10/711,015

Applicant(s)

CHEN ET AL.

Examiner

Kevin Quinto

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 13 April 2006.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-8 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-8 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date _____
- 4) ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: _____

DETAILED ACTION

Response to Arguments

1. This Office action is in response to the Request for Continued Examination (RCE) filed on April 13, 2006.
2. Applicant's arguments with respect to claims 1-8 have been considered but are moot in view of the new ground(s) of rejection.

Claim Objections

3. Claims 1-8 are objected to because of the following informalities: the use of the word "tertramethylsilane." Appropriate correction is required.
4. The examiner believes that the intended word is *tetramethylsilane* and has thus interpreted the claims in this manner.

Claim Rejections - 35 USC § 103

5. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

6. Claims 1-4 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ngo et al. (USPN 6,818,557 B1).

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7. In reference to claim 1, Ngo et al. (USPN 6,818,557 B1, hereinafter referred to as the "Ngo" reference discloses a similar fabrication process. Figures 1-4 of Ngo illustrate a copper damascene process where a dielectric layer (10) is formed over a substrate (not shown). A damascene opening is etched into the dielectric layer (10). The damascene opening is filled with copper (13A) or copper alloy (column 4, lines 59-65). The surface of the copper or copper alloy (13A) is treated with a hydrogen containing plasma (column 5, lines 49-62). The treated surface of the copper or copper alloy (13A) is reacted with trimethylsilane under plasma enhanced chemical vapor deposition (PECVD) conditions (column 6, lines 2-19). A silicon carbide capping layer (40) is in-situ deposited by PECVD (column 6, lines 2-19). Ngo supplies the trimethylsilane and then initiates the plasma (column 6, lines 2-19) but does not disclose simultaneously supplying trimethylsilane and initiating plasma to make the trimethylsilane react with the treated surface of copper or copper alloy. However it has been held to be prima facie obvious to reverse the order of the prior art process steps, *Ex parte Rubin*, 128 USPQ 440 (Bd. App. 1959). Furthermore the selection of any order of performing process steps is prima facie obvious in the absence of new or unexpected results, *In re Burhans*, 154 F.2d 690, 69 USPQ 330 (CCPA 1946). Therefore this limitation is not patentably distinguishable over Ngo. In addition, Ngo does not disclose using tetramethylsilane as the gas to form the silicon carbide film. However tetramethylsilane is a known material for use in the process to form silicon carbide films (see Hu et al., USPN 6,559,033 B1, column 11, lines 65-67 and Chen et al., US 2003/0134499 A1, p. 4, paragraph 36). The applicant is reminded in this regard that it has been held that a mere selection of known

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materials generally understood to be suitable to make a device, the selection of the particular material being on the basis of suitability for the intended use, would be entirely obvious. See *In re Leshin* 125 USPQ 416 and also *Sinclair & Carroll Co. v. Interchemical Corp.*, 325 U.S. 327, 65 USPQ 297 (1945). Therefore claim 1 is not patentable over the Ngo reference.

8. With regard to claim 2, figure 1 shows that the damascene opening is lined with a diffusion barrier layer (12). Ngo discloses forming a seed layer on the diffusion barrier layer (12) and forming a copper or copper alloy (13a) on the seed layer (column 6, lines 58-60).

9. In reference to claim 3, Ngo makes it clear that the damascene opening may comprise a contact or via hole in communication with a trench opening (column 7, lines 58-61).

10. With regard to claim 4, Ngo discloses that the treated surface of the copper or copper alloy (13A) takes place at a process temperature of 335°C at a possible reaction duration of 30 seconds (column 6, lines 2-19). The copper or copper alloys (13a) is reacted with trimethylsilane with a gas flow in the range of 32 to 160 sccm (column 2, lines 2-19) which overlaps the range, "100 to 5000 sccm" as claimed by the applicant.

The examiner would like to note:

In the case where the claimed ranges "overlap or lie inside ranges disclosed by the prior art" a prima facie case of obviousness exists. *In re Wertheim*, 541 F.2d 257, 191 USPQ 90 (CCPA 1976); *In re Woodruff*, 919 F.2d 1575, 16 USPQ2d 1934 (Fed. Cir. 1990). See MPEP 2144.05.

Thus claim 4 does not distinguish over the prior art reference of Ngo.

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11. Claims 5, 6, 7, and 8 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ngo et al. (USPN 6,818,557 B1) in view of Xia et al. (United States Patent Application Publication No. US 2003/0068881 A1).

12. In reference to claim 5, Ngo (USPN 6,818,557 B1) discloses a similar fabrication process. Figures 1-4 of Ngo illustrate a copper damascene process where a dielectric layer (10) is formed over a substrate (not shown). A damascene opening is etched into the dielectric layer (10). The damascene opening is filled with copper (13A) or copper alloy (column 4, lines 59-65). The surface of the copper or copper alloy (13A) is treated with a hydrogen containing plasma (column 5, lines 49-62). The treated surface of the copper or copper alloy (13A) is reacted with trimethylsilane under plasma enhanced chemical vapor deposition (PECVD) conditions (column 6, lines 2-19). A silicon carbide capping layer (40) is in-situ deposited by PECVD (column 6, lines 2-19). Ngo supplies the trimethylsilane and then initiates the plasma (column 6, lines 2-19) but does not disclose simultaneously supplying trimethylsilane and initiating plasma to make the trimethylsilane react with the treated surface of copper or copper alloy. However it has been held to be prima facie obvious to reverse the order of the prior art process steps, *Ex parte Rubin*, 128 USPQ 440 (Bd. App. 1959). Furthermore the selection of any order of performing process steps is prima facie obvious in the absence of new or unexpected results, *In re Burhans*, 154 F.2d 690, 69 USPQ 330 (CCPA 1946). In addition, Ngo does not disclose using tetramethylsilane as the gas to form the silicon carbide film. However tetramethylsilane is a known material for use in the process to form silicon carbide films (see Hu et al., USPN 6,559,033 B1, column 11, lines 65-67).

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and Chen et al., US 2003/0134499 A1, p. 4, paragraph 36). The applicant is reminded in this regard that it has been held that a mere selection of known materials generally understood to be suitable to make a device, the selection of the particular material being on the basis of suitability for the intended use, would be entirely obvious. See *In re Leshin* 125 USPQ 416 and also *Sinclair & Carroll Co. v. Interchemical Corp.*, 325 U.S. 327, 65 USPQ 297 (1945). Therefore this limitation is not patentable over the Ngo reference. Ngo does not disclose treating the silicon carbide capping layer with an ammonia plasma in order to remove oxygen from it. However such a plasma treatment is well known in the art. Xia et al. (United States Patent Application Publication No. US 2003/0068881 A1, hereinafter referred to as the "Xia" reference) discloses a silicon carbide layer which is treated with an in-situ ammonia plasma in order to remove contaminants from its surface (p. 4, paragraph 50). Ngo discloses that a silicon carbide layer free of contaminants is desirable in the art since it leads to a more reliable interconnect structure (column 8, lines 30-36). In view of Xia, it would therefore be obvious to treat the silicon carbide layer of Ngo with an ammonia plasma.

13. With regard to claim 6, figure 1 shows that the damascene opening is lined with a diffusion barrier layer (12). Ngo discloses forming a seed layer on the diffusion barrier layer (12) and forming a copper or copper alloy (13a) on the seed layer (column 6, lines 58-60).

14. In reference to claim 7, Ngo makes it clear that the damascene opening may comprise a contact or via hole in communication with a trench opening (column 7, lines 58-61).

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15. With regard to claim 8, Ngo discloses that the treated surface of the copper or copper alloy (13A) takes place at a process temperature of 335°C at a possible reaction duration of 30 seconds (column 6, lines 2-19). The copper or copper alloys (13a) is reacted with trimethylsilane with a gas flow in the range of 32 to 160 sccm (column 2, lines 2-19) which overlaps the range, "100 to 5000 sccm" as claimed by the applicant.

The examiner would like to note:

In the case where the claimed ranges "overlap or lie inside ranges disclosed by the prior art" a prima facie case of obviousness exists. In re Wertheim, 541 F.2d 257, 191 USPQ 90 (CCPA 1976); In re Woodruff, 919 F.2d 1575, 16 USPQ2d 1934 (Fed. Cir. 1990). See MPEP 2144.05.

Thus claim 8 does not distinguish over the prior art references of Ngo and Xia.

16. Claims 5, 6, 7, and 8 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ngo et al. (USPN 6,818,557 B1) in view of Yang et al. (USPN 6,365,527 B1).

17. In reference to claim 5, Ngo (USPN 6,818,557 B1) discloses a similar fabrication process. Figures 1-4 of Ngo illustrate a copper damascene process where a dielectric layer (10) is formed over a substrate (not shown). A damascene opening is etched into the dielectric layer (10). The damascene opening is filled with copper (13A) or copper alloy (column 4, lines 59-65). The surface of the copper or copper alloy (13A) is treated with a hydrogen containing plasma (column 5, lines 49-62). The treated surface of the copper or copper alloy (13A) is reacted with trimethylsilane under plasma enhanced chemical vapor deposition (PECVD) conditions (column 6, lines 2-19). A silicon carbide capping layer (40) is in-situ deposited by PECVD (column 6, lines 2-19). In addition, Ngo does not disclose using tetramethylsilane as the gas to form the silicon carbide film. However tetramethylsilane is a known material for use in the process to form silicon carbide films (see Hu et al., USPN 6,559,033 B1, column 11, lines 65-67 and

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Chen et al., US 2003/0134499 A1, p. 4, paragraph 36). The applicant is reminded in this regard that it has been held that a mere selection of known materials generally understood to be suitable to make a device, the selection of the particular material being on the basis of suitability for the intended use, would be entirely obvious. See *In re Leshin* 125 USPQ 416 and also *Sinclair & Carroll Co. v. Interchemical Corp.*, 325 U.S. 327, 65 USPQ 297 (1945). Therefore this limitation is not patentable over the Ngo reference. Ngo does not disclose treating the silicon carbide capping layer with an ammonia plasma in order to remove oxygen from it. However such a plasma treatment is well known in the art. Yang et al. (USPN 6365,527 B1, hereinafter referred to as the "Yang" reference) discloses a silicon carbide layer which is treated with an in-situ ammonia plasma in order to remove oxygen from the layer (column 2, lines 15-21). Yang further discloses that a silicon carbide layer free of oxygen is desirable in the art (column 1, lines 59-61) since it leads to a better copper barrier (column 3, lines 41-45). In view of Yang, it would therefore be obvious to treat the silicon carbide layer of Ngo with an ammonia plasma.

18. With regard to claim 6, figure 1 shows that the damascene opening is lined with a diffusion barrier layer (12). Ngo discloses forming a seed layer on the diffusion barrier layer (12) and forming a copper or copper alloy (13a) on the seed layer (column 6, lines 58-60).

19. In reference to claim 7, Ngo makes it clear that the damascene opening may comprise a contact or via hole in communication with a trench opening (column 7, lines 58-61).

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20. With regard to claim 8, Ngo discloses that the treated surface of the copper or copper alloy (13A) takes place at a process temperature of 335°C at a possible reaction duration of 30 seconds (column 6, lines 2-19). The copper or copper alloys (13a) is reacted with trimethylsilane with a gas flow in the range of 32 to 160 sccm (column 2, lines 2-19) which overlaps the range, "100 to 5000 sccm" as claimed by the applicant.

The examiner would like to note:

In the case where the claimed ranges "overlap or lie inside ranges disclosed by the prior art" a prima facie case of obviousness exists. In re Wertheim, 541 F.2d 257, 191 USPQ 90 (CCPA 1976); In re Woodruff, 919 F.2d 1575, 16 USPQ2d 1934 (Fed. Cir. 1990). See MPEP 2144.05.

Thus claim 8 does not distinguish over the prior art references of Ngo and Yang.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Kevin Quinto whose telephone number is (571) 272-1920. The examiner can normally be reached on M-F 8AM-5PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nathan Flynn can be reached on (571) 272-1915. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should

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you have questions on access to the Private PAIR system, contact the Electronic

Business Center (EBC) at 866-217-9197 (toll-free).


NATHANIEL
SUPERVISOR
TECHNOLOGY CENTER
MINER

KVQ